



## WEST BENGAL STATE UNIVERSITY

B.Sc. Honours Part-II Examination, 2020

### CHEMISTRY

#### PAPER: CEMA-IV

#### CEMAT [24-PA+24-PB] (25 MARKS) + CEMAP [24-PrA+24-PrB] (25 MARKS)

Time Allotted: 1 Hour

Full Marks: 25

*The figures in the margin indicate full marks.  
Candidates should answer in their own words and adhere to the word limit as practicable.  
All Symbols are of usual significance.*

#### CEMAT-24-PA

**Answer any one question from the following**

1. (a) Stopping potential for photo electrons emitted from metal surface irradiated by light of  $\lambda = 3000\text{\AA}$  is 1.91V. Find the work function of the metal. What is the new  $\lambda$  for which potential is 0.9V. 3
- (b) Determine whether the following functions are acceptable or not as state functions 2
  - (i)  $\sin x$  ( $0, \infty$ )
  - (ii)  $\tan^{-1} x$  ( $0 \leq x \leq \infty$ )
- (c) Show that the eigen function of a free particle of mass ' $m$ ' confined in a one-dimensional box of length ' $L$ ' are orthogonal. 2
- (d) Depict  $\psi^2$  vs  $r$  and RDF vs  $r$  plot for 1s orbital. 3
- (e) With the help of a Jablonski diagram depict the various photo physical processes by which a molecule in excited singlet state ( $S_2^v$ ) can return to the ground singlet state ( $S_0$ ). [ $v$  indicates the vibrational level, other terms have their usual significance]. 3
2. (a) Show that eigen values of a Hermitian operator are real. 2
- (b) At what wave length does the maximum in the radiant energy density distribution function for a black body occur if (i)  $T = 300$  K and (ii)  $T = 3300$  K. 3
- (c) Calculate the zero point energy of a linear simple harmonic oscillator consisting of a particle of mass  $2.33 \times 10^{-26}$  kg and force constant  $155 \text{ N m}^{-1}$ . 2
- (d) Hydrogen like wave function for 1s orbital is given by  $\psi = b_0 e^{-r/a_0}$  (where  $a_0$  is the Bohr radius). 4
  - (i) Find out the normalization constant  $b_0$ .
  - (ii) Specify the values of  $n$ ,  $l$  and  $m$  for  $1s$  electron.
  - (iii) Determine the most probable value of  $r$  in this state and comment on the result.

- (e) State Lambert Beers law. What is the unit of molar extinction coefficient? 2

### CEMAT-24-PB

Answer any *one* question form the following

3. (a) Define chemical potential. Is it a state function? Is it extensive or intensive? 4  
 Show that  $\mu_i = \left( \frac{\partial G}{\partial n_i} \right)_{T,P,x_j \neq i}$  can be written in terms of enthalpy.
- (b) For a reaction represented by  $\text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g})$ ,  $K_P = 1.7 \times 10^{12}$  at 300 K. Calculate  $K_P$  for  $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$ . 2
- (c) At 25°C for a cell, having the cell reaction  $\text{Sn} + \text{Sn}^{4+} = 2\text{Sn}^{2+}$ , the equilibrium activity of  $\text{Sn}^{2+}$  is 0.1. What is that of  $\text{Sn}^{4+}$  ion? [Given at 25°C the standard reduction potential for the system  $\text{Sn}^{4+}/\text{Sn}^{2+}$  is 0.15 V and that for  $\text{Sn}^{2+}/\text{Sn}$  is -0.136V]. 3
- (d) Draw the equivalent conductance vs.  $\sqrt{c}$  plot of HCl and Acetic acid. Explain. 3
4. (a) Derive Clausius-Clapeyron equation thermodynamically for liquid  $\rightleftharpoons$  vapour equilibrium. 3
- (b) Plot  $K_p$  vs.  $1/T$  for an exothermic reaction. 1
- (c) In a study of the water - gas shift reaction,  $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g})$ ; a mixture of  $\text{CO}_2$  and  $\text{H}_2$  initially containing 42.4 mol%  $\text{H}_2$  was brought to equilibrium in a closed vessel at 1259 K. The system was then found to contain 15.2%  $\text{H}_2$ . Calculate  $K_p$  at 1259 K. 2
- (d) What molality of  $\text{Al}_2(\text{SO}_4)_3$  has same ionic strength as a 0.5 molal  $\text{Ca}(\text{NO}_3)_2$ . 2
- (e) For the electrochemical cell  $\text{Pb} / \text{PbSO}_4(\text{s}) / \text{CuSO}_4(0.2\text{M}) / \text{CuSO}_4(0.02\text{M}) / \text{PbSO}_4(\text{s}) / \text{Pb}$ , answer the following questions 4
- (i) Name the type of cell
- (ii) Write the reactions at the 2 electrodes and the overall cell reaction
- (iii) Find  $\Delta G^\circ$  and  $K$  of the cell reaction.

**N.B. :** Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.

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